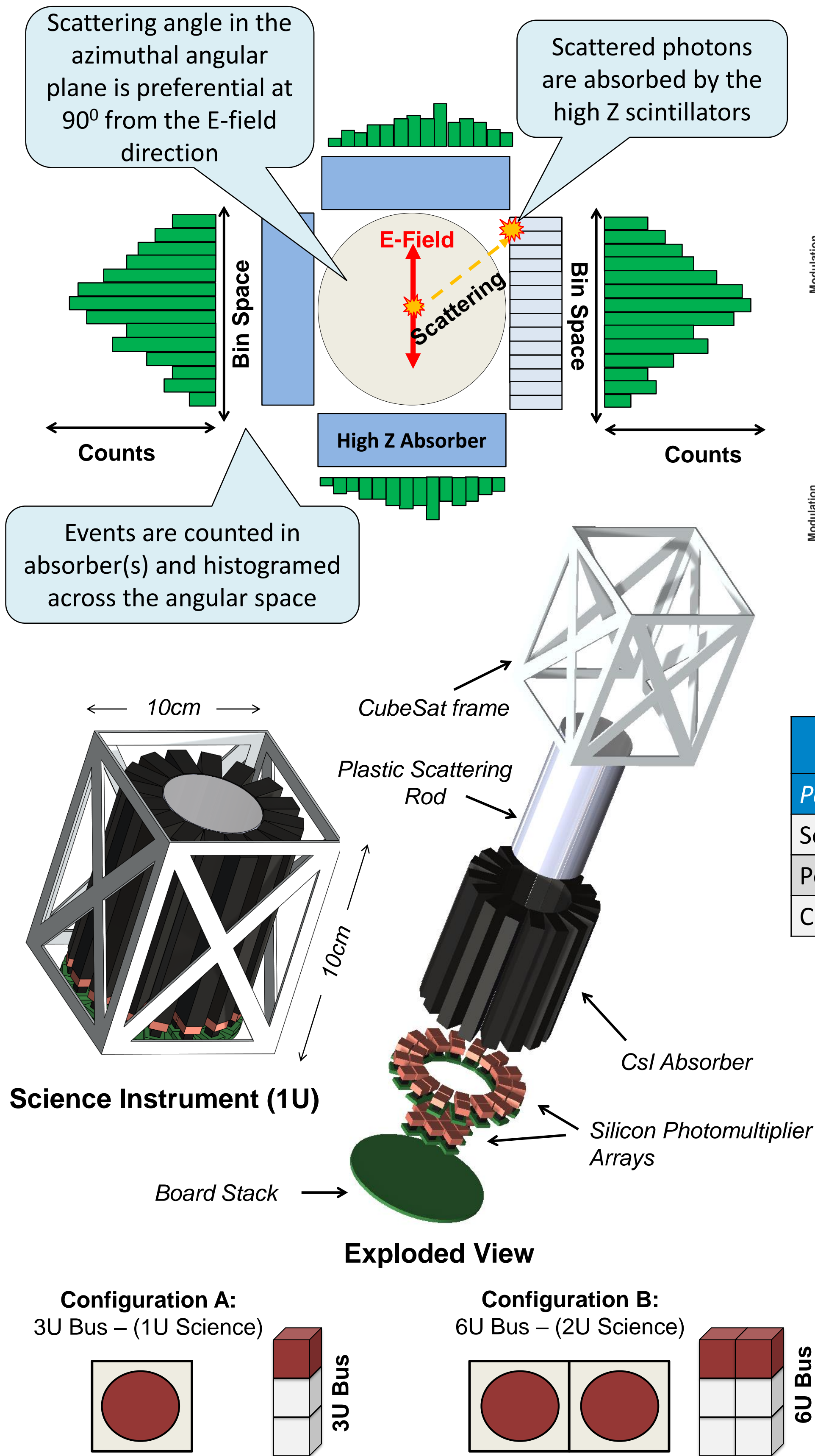


Development of a Gamma-Ray Scattering Polarimetry Detector for CubeSats

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Instrument Operation Principles

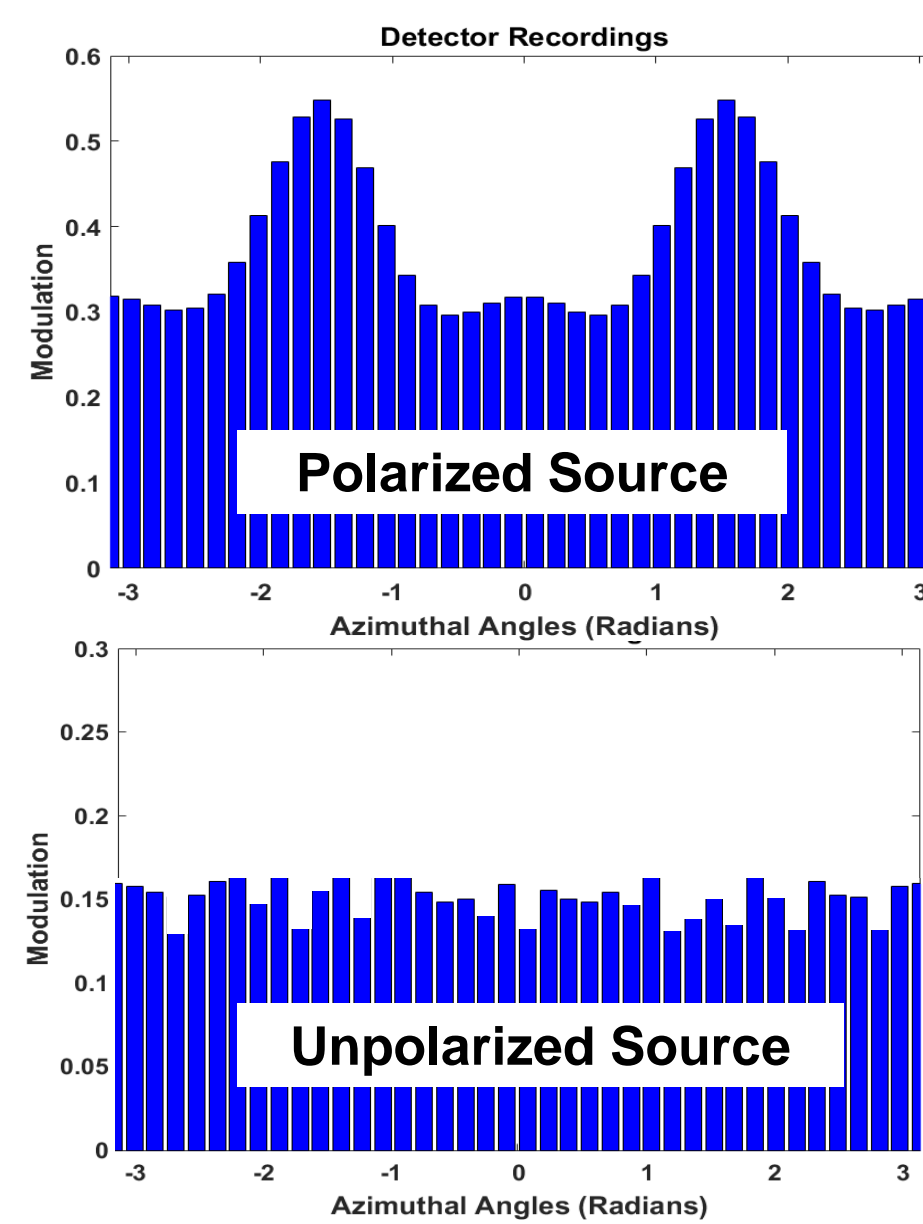
The instrument uses a Compton scattering polarimetry architecture which uses a central scattering rod and records the scattering distribution in the azimuthal plane of the detector.



Performance Simulation

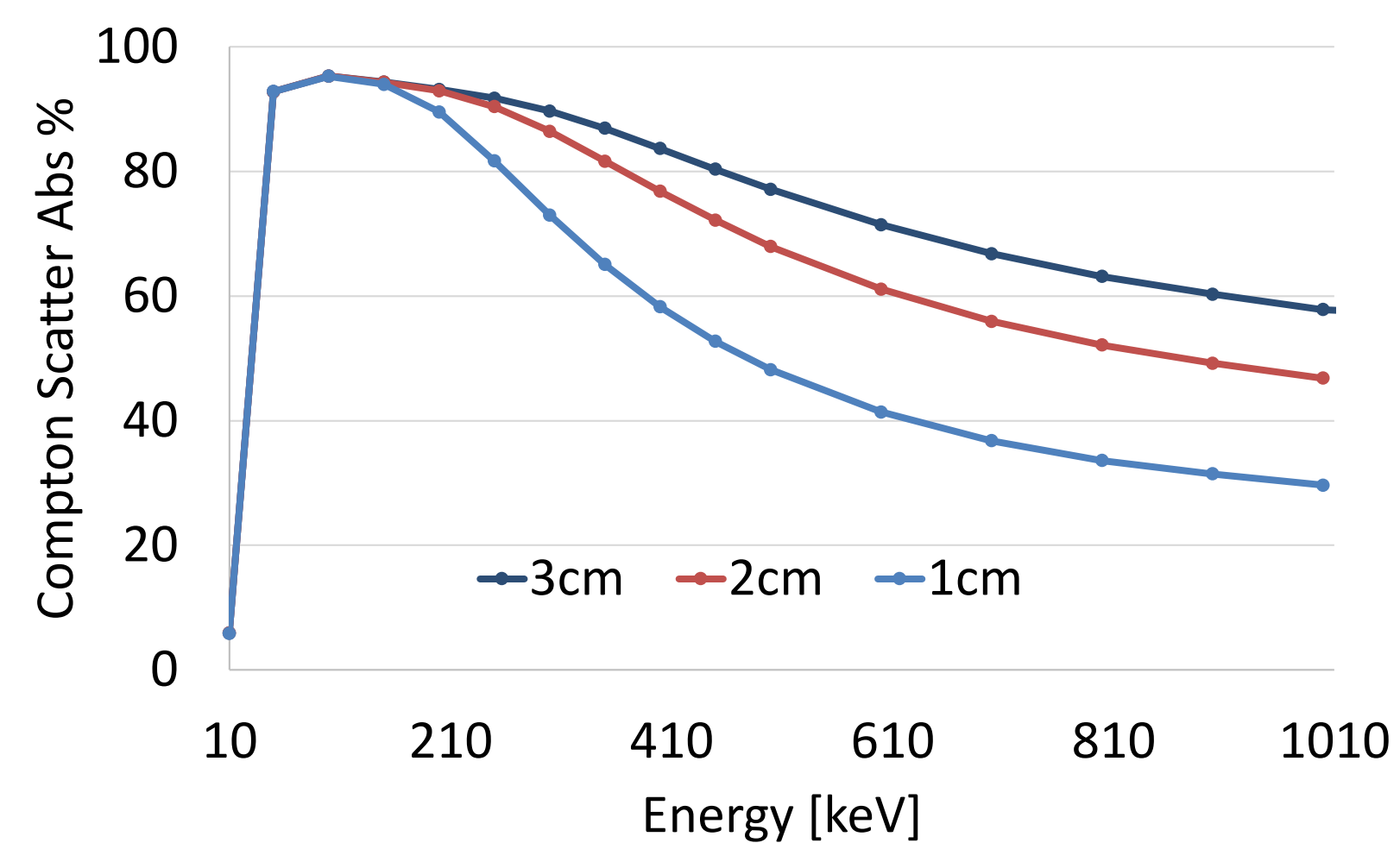
Simulations are run using GEANT4 with a basic scatter rod of plastic scintillator surrounded by Cesium Iodide scintillator. The simulation results are used as the photon detection efficiency of our detector. We consider the depth of the scattering rod and absorber thickness against the percentage of scatter events.

Detector Histogram Simulation

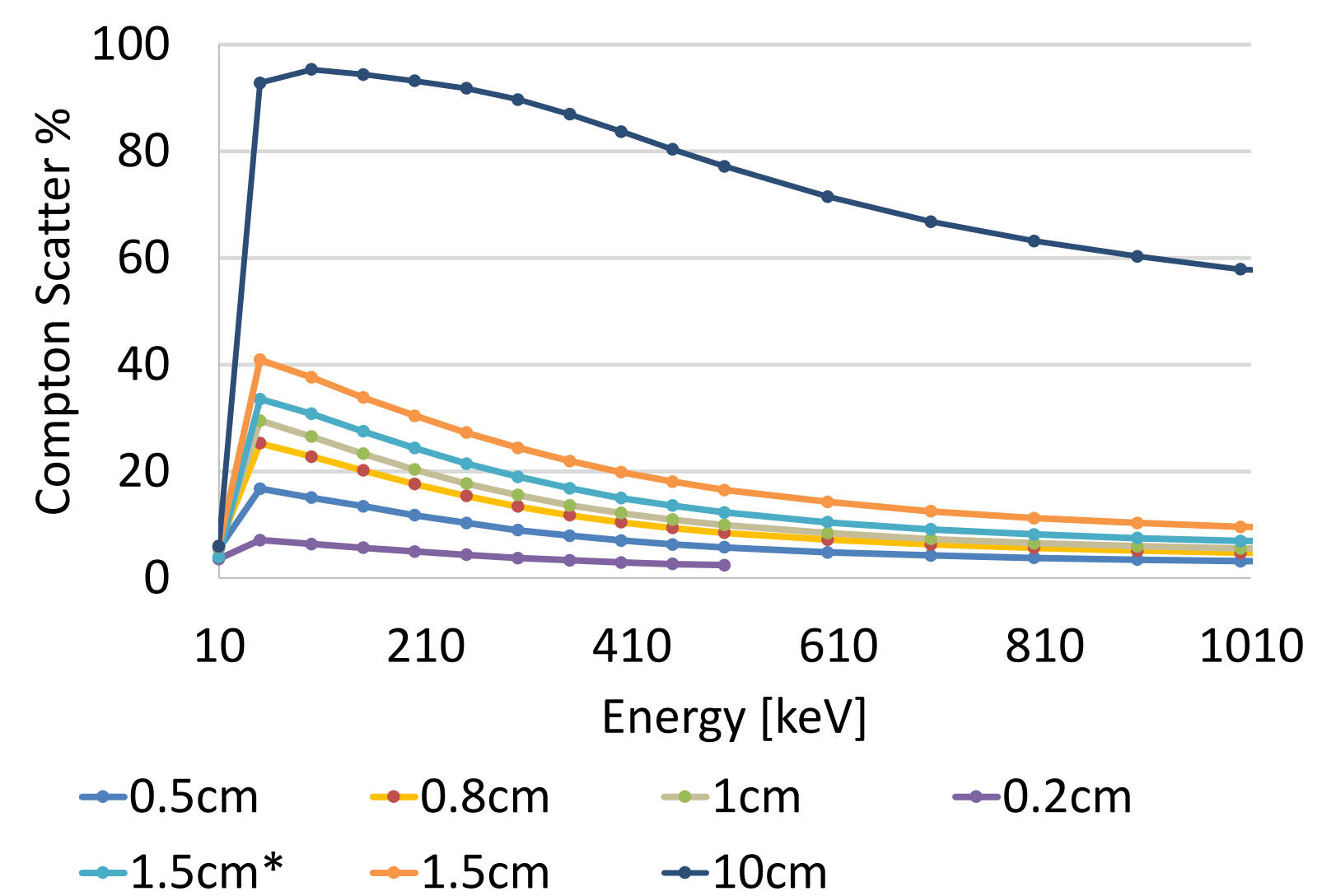


Instrument Parameters		
Parameter	Config A	Config B
Sens. Area	12.56cm ²	25.12cm ²
Power	1.5W	3W
Cost	~\$15,000	~\$30,000

Absorber Thickness vs Detection %



Rod Depth vs Scattering %



The minimum detectable polarization is measure of observation time to detect with 99% probability a certain polarization percentage. This measures detector performance for targets in a given timeframe.

Minimum Detectable Polarization

Source	Type	Energy [keV]	Flux Est. [cnts/s /cm ²]	Configuration A		Configuration B	
				Obs Time (5% Pol.) [days]	Obs Time (10% Pol.) [days]	Obs Time (5% Pol.) [days]	Obs Time (10% Pol.) [days]
Cyg X-1	Stellar BH	25-180	0.54	389	97	97	24
Vela X-1	HMXB	42-115	5.1	4.4	1.1	1.1	0.27
Crab	Pulsar	1-100	8.9	1.4	0.35	0.35	0.08
GRO J0422	Stellar BH	20-600	1	160	40	40	10
GRO J655	BH	20-100	0.4	1000	250	250	63

Science Potential

Polarization is a new frontier in astrophysics. The properties of polarization allow insight into the production mechanisms of X-ray and Gamma ray spectrums that imaging cannot give. Primary mechanisms of polarization are from synchrotron emission. Since synchrotron emission is highly dependent on the magnetic field morphology, we can probe the models of magnetic fields for neutron stars and relativistic jets via polarimetry. The corona of black holes also can scatter polarized photons which can measure the corona properties through this transfer, this is also dependent on the angle from the accretion plane.

Conclusions

The Compton scattering instrument will be sensitive to a wide range of energies from hard X-ray into the gamma ray. Our mission will be to survey targets and gather polarization percentage and angle measurements of the bright X-ray and gamma ray catalog. Astrophysics measurements are possible in a CubeSat volume, small missions like these have great possibility for swarms and technology demonstrations for larger future instruments. We will propose to CSLI and ROSES solicitations this year for an intended flight around 2020.

Acknowledgements

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